(19) JAPANESE PATENT OFFICE

PATENT ABSTRACTS OF JAPAN

(11) Publication number: **06172995 A**

(43) Date of publication of application: **21. 06 . 94**

(51) Int. Cl **C23C 14/35**
H01L 21/203
H01L 21/31

(21) Application number: **04329346**

(22) Date of filing: **09 . 12 . 92**

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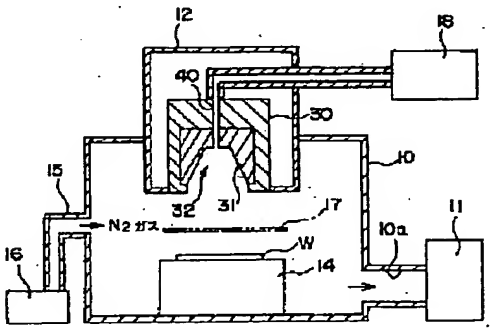
(54) MAGNETRON SPUTTERING DEVICE AND SPUTTERING GUN

(57) Abstract:

PURPOSE: To provide the magnetron sputtering device and sputtering gun capable of uniformly depositing sputtered particles, executing sputtering in the state of maintaining the low sputtering gaseous pressure over the entire part of a sputtering treatment space and executing reactive sputtering with high efficiency.

CONSTITUTION: This magnetron sputtering device is constituted of a vacuum vessel 10, the sputtering gun 30 for ejecting the sputtered particles, a support 14 for supporting a wafer in this vacuum vessel and a reactive gas supplying means 14 for supplying reactive gases into the vacuum chamber. The sputtering gun 30 has a target 31 having a recessed part 32, a sputtering gas supplying means 18 for supplying the sputtering gas to this recessed part, an electric field forming means for forming an electric field in the recessed part and a magnetic field forming means for forming a magnetic field contg. the component orthogonal with the electric field in the recessed part.



* NOTICES *

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CLAIMS

[Claim(s)]

[Claim 1] It is the magnetron sputtering system carry out that the resultant which it had the magnetic field means forming which is characterized by to provide the following, and which forms a magnetic field, and a spatter particle was begun to beat from the aforementioned target by the plasma formed in the aforementioned crevice, the aforementioned reactant-gas supply means supplied reactant gas to the aforementioned spatter particle in the aforementioned crevice and the isolated field, and the aforementioned spatter particle and the aforementioned reactant gas reacted, and was formed deposits on the aforementioned processed object as the feature. Vacuum housing. The sputtering gun for being arranged in it and injecting a spatter particle. The base material which supports the processed object which should form a thin film in the aforementioned vacuum housing. It is the component to which a reactant gas supply means to supply reactant gas in the aforementioned vacuum housing is provided, and the aforementioned crevice and the aforementioned sputtering gun cross at right angles to the aforementioned electric field with the target which has a crevice, a sputtering gas supply means to supply sputtering gas to the aforementioned crevice, and the electric-field means forming which forms electric field in the aforementioned crevice and generates the plasma of the aforementioned sputtering gas.

[Claim 2] The sputtering gun characterized by to make the resultant particle which it had the magnetic field means forming which is characterized by to provide the following, and which forms a magnetic field, and the aforementioned plasma and a reactant-gas supply means supply reactant gas to the spatter particle begun to beat by the aforementioned plasma from the aforementioned target in the isolated position, and the aforementioned spatter particle and the aforementioned reactant gas reacted, and was formed inject. The target which has a crevice. A sputtering gas supply means to supply sputtering gas to the aforementioned crevice. Electric-field means forming which forms electric field in the aforementioned crevice and generates the plasma of the aforementioned sputtering gas. The component which intersects perpendicularly with the aforementioned crevice to the aforementioned electric field.

[Claim 3] The magnetron sputtering system according to claim 1 characterized by having further a means to introduce negative direct-current bias into the aforementioned processed object.

[Claim 4] The magnetron sputtering system according to claim 1 by which it is having-further-means to introduce negative AC bias into aforementioned processed object characterized.

[Claim 5] The magnetron sputtering system according to claim 1 characterized by having further a means to introduce a negative direct current and an AC bias into the aforementioned processed object.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the magnetron sputtering system and sputtering gun for carrying out the vacuum evaporationo of the thin film to for example, a semiconductor wafer.
[0002]
[Description of the Prior Art] As for a magnetron sputtering system, the substrate (for example, semiconductor wafer) and sputtering gun by which a thin film should be formed in a vacuum chamber are established, and the sputtering gun has the target and sputtering electrode which were prepared so that a substrate might be countered.
[0003] While being maintained on the occasion of sputtering by sputtering gas (argon gas is generally used) atmosphere where the inside of a vacuum chamber is a mTorr order grade, generally negative voltage is impressed to a sputtering target from DC power supply through the sputtering electrode which has a cooler style. On the other hand, generally members, such as an anode which touches a sputtering target and a sputtering electrode through a several mm gap, and a shield, are maintained by grounding potential with a vacuum chamber. A sputtering target rear face is approached, a magnetic circuit is prepared, and, thereby, a parallel magnetic field is impressed to a sputtering target front face. Therefore, rectangular electromagnetic field will be formed in a sputtering target surface portion, cyclone movement arises into the electron within plasma by this, and sputtering comparatively stabilized by the low pressure can be performed.
[0004] Generally as a target of the conventional sputtering gun, it has the reverse cone type spatter side which has monotonous type a thing or loose inclination, and the thing of bigger aperture than a wafer is used.
[0005] While the aperture of a beer hall or a contact hole becomes small with 0.5 microns as the degree of integration of IC becomes high in recent years, since the thickness of each class does not change so much, it is becoming what has the big aspect ratio of a beer hall or a contact hole. Thus, when a thin film is formed in the wafer by which densification was carried out and the conventional plate-like target is used, the following problems arise.
[0006] That is, by the sputtering system of the composition using the plate-like target 2, as shown in drawing 10 , the spatter particle which is begun to beat from the front face of a target 2 and which is carried out has the component of various directions, as each portion of a target 2 is shown in a circle 3 in approximation.
[0007] For a diameter, the depth is [highly-integrated ULSI1 of four or more M-DRAMs used as a substrate] 1 micron () at 0.5 microns. namely, when the contact hole (or beer hall) 5 of an aspect ratio 2 is formed and the electric conduction film 4 is formed in such ULSI1 by sputtering Since not only the spatter particle from a perpendicular direction but all angles to a spatter particle carries out incidence to a contact hole 5 Deposition of the thing spatter particle in the portion of the shoulder of a contact hole 5 becomes large, and plugs up the entrance of a contact hole 5, and it becomes impossible to form the electric conduction film of thickness sufficient as a result for contact hole 5 inside. Especially, in a contact hole or a beer hall 0.5 microns or less, it is pointed out from the conventional monotonous type spatter gun the coverage (it is hereafter called a step coverage) of a level difference and that especially the alimentation (it is hereafter called a bottom coverage) to a hole pars basilaris ossis occipitalis falls to 10% or less.

[0008] Moreover, for generating of plasma, at the conventional magnetron sputtering system, spatter gas pressure is 1mTorr. Unless it is a high pressure, it is not stabilized, but in order to have to raise the whole processing space to the stabilized pressure, it will become the amount which cannot disregard the collision with a spatter particle and a spatter gas particle. Therefore, it cannot be said that the conventional magnetron sputtering system is enough as spatter efficiency.
[0009] On the other hand, in the field of a semiconductor, compound films, such as TiN and a TiNO film, are formed by reactive sputtering. Generally, using the mixed gas of the nitrogen as inert gas and reactant gas, such as argon gas, or nitrogen, and oxygen, reactive sputtering makes a sputtering particle and reactant gas react, and forms a film.
[0010] However, a new problem as shown below arises in reactive sputtering using such reactant gas. namely, -- if sputtering is performed using reactant gas like nitrogen gas in this way -- inert gas (argon gas) -- sputtering efficiency will fall about to 1/5 as compared with the case of being independent Moreover, the film deposited on inter-electrode tends to exfoliate, and it has become the cause of producing unusual electric discharge.
[0011] This invention is made in view of this situation, and the spatter particle of amount sufficient also in the hole of a highly-integrated wafer can be deposited, and it is possible to carry out sputtering, where spatter gas ** of the whole sputtering processing space is maintained low, and it is still more efficient, and aims at offering the magnetron sputtering system which can carry out reactive sputtering, and a sputtering gun.
[0012]
[Means for Solving the Problem] The sputtering gun for 1st this invention being arranged in it with a vacuum housing, and injecting a spatter particle, The base material which supports the processed object which should form a thin film in the aforementioned vacuum housing, and a reactant gas supply means to supply reactant gas in the aforementioned vacuum housing are provided. the aforementioned sputtering gun The target which has a crevice, and a sputtering gas supply means to supply sputtering gas to the aforementioned crevice, The electric-field means forming which forms electric field in the aforementioned crevice and generates the plasma of the aforementioned sputtering gas, It has the magnetic field means forming which forms the magnetic field containing the component which intersects perpendicularly with the aforementioned crevice to the aforementioned electric field. A spatter particle is begun to beat from the aforementioned target by the plasma formed in the aforementioned crevice. the aforementioned reactant gas supply means In the aforementioned crevice and the isolated field, reactant gas is supplied to the aforementioned spatter particle, and the magnetron sputtering system characterized by the resultant in which the aforementioned spatter particle and the aforementioned reactant gas reacted to, and were formed accumulating on the aforementioned processed object is offered.
[0013] The target which has [2nd] a crevice, and a sputtering gas supply means to supply sputtering gas to the aforementioned crevice, The electric-field means forming which forms electric field in the aforementioned crevice and generates the plasma of the aforementioned sputtering gas, The magnetic field means forming which forms the magnetic field containing the component which intersects perpendicularly with the aforementioned crevice to the aforementioned electric field, It has the aforementioned plasma and a reactant gas supply means to supply reactant gas to the spatter particle begun to beat by the aforementioned plasma from the aforementioned target in the isolated position. The sputtering gun characterized by making the resultant particle in which the aforementioned spatter particle and the aforementioned reactant gas reacted to, and were formed inject is offered.
[0014]
[Function] In this invention, since a crevice is established in the target of a sputtering gun, plasma is formed into it and a spatter particle is made to inject, a spatter particle is injected with very high directivity. Therefore, the spatter particle of amount sufficient also in the hole of a highly-integrated wafer can be deposited. Moreover, since it can apply to a nose-of-cam side from the end face side of a crevice and the pressure gradient of sputtering gas can be made to form in case gas is supplied to a crevice, sputtering can be performed where the processing space in a vacuum chamber is maintained to low voltage. Therefore, the opportunity for a spatter particle to collide with gas in the processing space where a spatter particle moves can be decreased, and sputtering efficiency is very high.

Furthermore, since reactant gas is supplied to a spatter particle in the crevice where plasma is generated, and the isolated position, it is efficient and reactive sputtering can be performed.
[0015]
[Example] Hereafter, the example of this invention is explained with reference to an accompanying drawing.
[0016] Drawing 1 is the outline block diagram showing the magnetron sputtering system concerning one example of this invention. This magnetron sputtering system is equipped with the reactant gas supply means in order to supply reactant gas (for example, nitrogen gas) in the vacuum chamber 10 with the vacuum chamber 10 to which membrane formation processing is performed in it, the assembly 12 of the magnetron-sputtering ring gun 30, the source 18 of sputtering gas supply for supplying sputtering gas (for example, argon gas) to the sputtering gun 30, and the base material 14 for supporting the semiconductor wafer W as a processed object.
[0017] Exhaust-port 10a is formed in the side attachment wall of the vacuum chamber 10, and the vacuum pump 11 is connected to this exhaust-port 10a. And the inside of a chamber 10 is held at a desired degree of vacuum by exhausting the inside of a chamber 10 with this vacuum pump 11.
[0018] The base material 14 is formed in the pars basilaris ossis occipitalis of the vacuum chamber 10, and has the heating function. An assembly 12 is arranged above this base material 14. The sputtering gun 30 included in the assembly 12 is equipped with the target 31 which has a crevice 32, and the spatter of this target 31 is carried out by the plasma of the sputtering gas supplied from the above-mentioned source 18 of gas supply. Thereby, a spatter particle is injected towards Wafer W. In addition, the detailed structure of the sputtering gun 30 is mentioned later.
[0019] The shutter 17 is formed between the wafers W on an assembly 12 and a base material 14, where a shutter 17 is closed, reserve sputtering is performed, and actual sputtering processing is performed where a shutter 17 is opened.
[0020] The reactant gas supply pipe 15 is connected to exhaust-port 10a of the vacuum chamber 10, and the side attachment wall of an opposite side, and the reactant gas source of supply 16 mentioned above to this supply pipe 15 is connected. And reactant gas, such as nitrogen gas, is supplied in a chamber 10 through the reactant gas supply pipe 15 from the reactant gas source of supply 16.
[0021] The sputtering gun 30 which constitutes an assembly 12 is constituted like drawing 2 . That is, the sputtering gun 30 consists of a target 31, an anode 34, the target clamp assembly 35, the target cooling block 36, an insulating material 37, a magnet 38, and a yoke 39.
[0022] A target 31 consists of membrane formation material, for example, aluminum, copper, titanium, a titanium nitride, etc., and the crevice 32 which carries out opening is formed in the field which counters Wafer W. A crevice 32 is presenting the back taper configuration to which aperture becomes large as it goes to an opening edge. The gas feed holes 40 are formed in the pars basilaris ossis occipitalis of this crevice 32, and sputtering gas (plasma gas), such as argon gas, is supplied to a crevice 32 through the gas feed holes 40 from the source 18 of the above-mentioned gas supply.
[0023] The magnet 38 is arranged in the upper part of a target 31, i.e., the tooth back of a target 31, and the pole piece 41 which consists of the magnetic substance so that a gas passageway may be specified is formed in the target 31 side of a magnet 38. The yoke 39 is formed so that the outside of the sputtering gun 30 may be specified, and it serves as a closed circuit with between a target 31 and magnets 38 and between an anode 34 and magnets 38 with this yoke 39. [magnetic] Line of magnetic force M is formed between the anodes 34 and magnets 38 which were formed in the opening side of a target 31 as a result. That is, a magnetic field is formed in a crevice 32.
[0024] An anode 34 consists of aluminum and has bigger opening equivalent to opening of a target 31 or than this. And it also has a role of the shield ring which shields a spatter particle.
[0025] The target cooling block 36 has the refrigerant path 42, and is presenting approximate circle tubed, and the target 31 has fitted into the space of the inside. And between targets 31 is being fixed by the target clamp assembly 35 in the opening one end. An anode 34 inserts a pin 44 in a part for the notch 43 prepared in a yoke 39 and itself, and is fixed to it, and the target clamp assembly 35 inserts a pin 44 in a part for the notch 43 prepared in the itself and target cooling block 36, and is fixed to it. The target and the anode are electrically insulated by the insulating material 37.
[0026] A refrigerant is supplied to the refrigerant path 42 of the target cooling block 36 through the refrigerant feeding-and-discarding water pipes 42a and 42b, and, thereby, a target 31 is cooled. In

addition, the cooling ring 46 is formed in the outside of a yoke 39, a refrigerant is supplied to the refrigerant path 47 in it through the cooling water feeding-and-discarding pipes 47a and 47b, and, thereby, a yoke 39 is also cooled.

[0027] The target 31 is connected to DC power supply 45, and the voltage of -300--800V is impressed from this power supply 45. Moreover, the anode 34 is grounded. Therefore, rectangular electromagnetic field are formed of the component which intersects perpendicularly with electric field among the magnetic fields which electric field were formed in between [32] an anode 34 and targets 31 (i.e., a crevice), and were formed into it.

[0028] Thus, in the magnetron sputtering system constituted, first, the semiconductor wafer W as a processed object is laid on a base material 14, and evacuation of the inside of the vacuum chamber 10 is carried out to for example, a 10-9Torr base with a vacuum pump 11. And the move mechanism 20 performs sputtering, where relative movement is produced between the semiconductor wafers W as the sputtering gun 30 and a processed object.

[0029] the crevice 32 of the target [in / the sputtering gun 30 / on the occasion of sputtering] 31 -- the gas introduction from the source 18 of gas supply -- a hole 40 -- leading -- sputtering gas, i.e., plasma production gas, such as Ar gas, -- supplying -- 0.05 - 10mTorr It holds to a pressure and the voltage of -300--800V is impressed between a target 31 and an anode 34. Thereby, the plasma of sputtering gas is generated in a crevice 32.

[0030] The electron 48 of the plasma field 33 carries out cyclone movement by the rectangular electromagnetic field formed of the electric field impressed to line of magnetic force M and a target, the probability of colliding with a neutral argon particle increases, and ionization is promoted. The ionized sputtering gas collides with the wall of a target 31 by electric field. Thereby, the spatter particle S is ****(ed) from a target 31. Although the spatter particle S begun to beat is injected from opening of a target, it deposits again the spatter particle which hit the wall of a target 31 on a target. However, again, the spatter also of the spatter particle deposited in this way is carried out by argon ion, it is caudad injected from opening of a target by it, and the flow of the directive high spatter particle S is acquired as a result.

[0031] in this case, gas introduction of a target 31 -- a hole 40 has a small path, and since the path is large toward the opening edge of a crevice 32, the pressure gradient of introductory gas is formed toward the sputtering processing space 60 from a gas introduction end face, and as for the processing space 60, plasma is stabilized by low voltage, and it is generated For example, plasma is stabilized in the plasma production field 33, and it is a generable pressure, for example, 1mTorr. The pressure to which it considers as order and a spatter particle can decrease an opportunity to collide with gas in the processing space 60, for example, 0.1mTorr(s), It can consider as order. Moreover, the pressures in a crevice 32 are low 0.1mTorr(s) 1 ******** from the former. Order, for example, 0.2mTorr(s), It is possible to make plasma generate but. In this case, the pressure of the processing space 60 can be reduced further.

[0032] Thus, the spatter particle which has high directivity in the state where the pressure of the sputtering processing space 60 is low can perform sputtering. Therefore, when performing sputtering processing to the wafer with which the contact hole was formed, with a high step coverage and a high bottom coverage, it is efficient and a thin film can be formed.

[0033] When performing reactive sputtering, reactant gas, for example, nitrogen gas, is introduced into the processing space 60 of the vacuum chamber 10 through the reactant gas supply pipe 15 from the reactant gas source of supply 16. Since the spatter particle S from the sputtering gun 30 faces to Wafer W through the processing space 60, reactant gas will be supplied toward a spatter particle. It will react with a spatter particle, a resultant will be generated by this, and this resultant will deposit the reactant gas supplied toward the spatter particle on Wafer W. For example, when a spatter particle is [reactant gas] nitrogen gas by titanium, TiN will be formed on Wafer W. In this case, since reactant gas is supplied to the field isolated from the crevice 32 in which the plasma of sputtering gas is formed, efficient reactive sputtering is attained.

[0034] In addition, the directivity of a spatter particle can be adjusted by changing the length of the anode 34 prepared in the nose-of-cam side of a target 31. That is, an anode 34 functions also as the shield ring. For example, an anode 34 is lengthened to raise the directivity of a spatter particle more.

[0035] If such sputtering processing is repeated, a target 31 is gradually exhausted by generating of a

spatter particle, and the spatter section 49 becomes large as dashed line 49a shows. However, it is only that the size of a crevice 32 changes in this case, and an above-mentioned function does not fall.

[0036] In addition, a target 31 is made by the size somewhat smaller than the size of space so that it may be easily inserted in the space of the target cooling block 36. That is, between a target 31 periphery side and the inner skin of a cooling system, it is constituted so that it may have the path clearance of the grade which the desorption of the target 31 can be carried out easily, and is stuck to the inner skin of the target cooling block 36 according to the thermal expansion of a target 31. Therefore, since a target becomes when exchanging the exhausted target, and it is reduced to low temperature, a gap can exist between a target 31 and the target cooling block 36, a target 31 can be demounted from the target cooling block 36 very easily, and a target new again can be attached. And by the heat which plasma will generate if voltage is impressed to a target electrode, and is generated in that case, a target 31 and the target cooling block 36 expand, and both are certainly fixed. Therefore, the heat of a target 31 can cool a target 31, without preparing a cooling means in target 31 the very thing, since it is told to the target cooling block 36. Therefore, a target 31 can be made into the easy structure of forming the feed holes 40 of gas. Moreover, the cooling water feeding-and-discarding water pipe to the target cooling block 36 does not have the need of detaching and attaching once it fixes, and can also make the water-works mechanism of cooling water easy.
[0037] As a configuration of the crevice 32 of a target 31, various things are employable. For example, the structure shown in (a) - (b) of drawing 3 is employable. In (a), the bottom has become [the point of a crevice 32] funnel-like with the cylinder, and the gas feed holes 40 are formed in the core of the bottom. In (b), the bottom has become [the point of a crevice 32] semi-sphere-like by the shape of a cone, and the gas feed holes 40 are carrying out opening to the core of a bottom like the example of (a). the shape of a cone which cut the crowning of a crevice 32 in (c) (a square drill is sufficient) -- becoming -- **** -- gas supply -- the hole 40 is too formed in the center of a bottom Next, the case where what has two or more sputtering guns as an assembly is used is explained.
[0038] When a processed object is enlarged more than a 8 inch wafer, in order to form a thin film in all the fields of a processed object for a short time, two or more sputtering guns are needed. The equipment configuration in this case is shown in drawing 4 . The other point is substantially the same, although assembly 12a which has two or more sputtering guns 30 instead of an assembly 12 is prepared as compared with the equipment of drawing 1 and also the equipment of drawing 4 differs at the point equipped with the move mechanism 20 which moves a base material 14.
[0039] The move mechanism 20 is established under the base material 14, and is connected with the base material 14 by driving shaft 14a. This move mechanism 20 is equipped with a perpendicular slip (Z direction), the 1st move section 21 which makes it rotate (the direction of theta), and the 2nd move section 22 which carries out horizontal displacement for the base material 14.
[0040] Rotation of a motor is changed into straight-line driving force according to a ball-thread mechanism etc., and the installation base 14 connected with driving shaft 14a is moved up and down, and the 1st move section 21 can rotate a base material 14 by rotation of a motor.
[0041] The 2nd move section 22 is equipped with the X table 23, the rail 24 for X tables, the Y table 25, the rail 26 for Y tables, and the pedestal 27. The X table 23 can move in the direction of X with the 1st mechanical component 21 in a rail 24 top. Moreover, the Y table 25 can move in the direction (direction which intersects perpendicularly in the direction of X) of Y with the 1st move section 21 and X table 23 in the rail 26 top for Y tables prepared on the pedestal 27.
[0042] In addition, as mentioned above, since the 1st move section 21, the X table 23, and the Y table 25 are independently movable, respectively, the installation base 14 connected with driving shaft 14a becomes possible [moving in X, Y, Z, and the direction of theta independently, respectively].
[0043] Since the move mechanism 20 is formed in the exterior of the vacuum chamber 10, the heat and dust generated from a drive can prevent the bad influence which it has on the vacua in the vacuum chamber 10.
[0044] Bellows 28 is formed between the bottom of a base material 14, and the bottom of the vacuum chamber 10. In case a base material 14 moves to a Z direction, it expands and contracts, and in case bellows 28 moves in X and the direction of Y, it deforms in the direction to which it inclined

to the vertical axis. Therefore, even if a base material 14 moves along with X, Y, and a Z direction according to the move mechanism 50, the vacua in a vacuum chamber is maintainable.

[0045] Assembly 12a consists of seven sputtering guns 30, and those targets are arranged as shown in drawing 5 . In drawing 5 , seven targets 31 are arranged at each vertex of the right hexagon which makes Center A and this center A of spatter gun assembly 12a the center of gravity. according to this array -- the sputtering gun 30 -- the maximum -- **** -- it becomes possible to arrange Therefore, it becomes possible to make spatter gun assembly 12a into the minimum using the sputtering gun 30 which has a fixed size, and is advantageous in respect of space efficiency: However, various conditions, such as a size of not only this array but the wafer W and a size of opening of the sputtering gun 30, can determine the array of the sputtering gun 30 suitably. Thus, when assembly 12a which has two or more sputtering guns 30 is prepared, the reason which needs the move mechanism 20 is explained below.

[0046] Since the crevice 32 is formed in the target 31 of the sputtering gun 30, as mentioned above, the spatter particle S is injected with high directivity. Therefore, membrane formation is presented with many spatter particles S which fly perpendicularly mostly in the hole which exists in the range of the aperture of a target 31, and the position which counters. However, the spatter particle by which Wafer W goes to the wafer position which counters the mid-position of two adjoining targets 31 as it is fixation decreases. Moreover, the vertical component of a spatter particle decreases. That is, when Wafer W is fixation, the alimentation within the Wth page of the wafer of a spatter particle and dispersion of the degree of incident angle arise. Therefore, in order to avoid such un-arranging, relative displacement is produced between the sputtering gun 30 and Wafer W according to the move mechanism 20. The example of such relative displacement is explained with reference to drawing 5 and drawing 6 .

[0047] It is made to carry out the raster scan of the wafer W in the direction of X and the direction of Y which are a direction parallel to the principal plane of the wafer W shown in drawing 6 as an example. this -- a case -- a raster scan -- for example, -- drawing 5 -- being shown -- as -- mutual -- adjoining -- two -- a ** -- a target -- 31 -- a center position -- A -- B -- distance -- L -- one -- C -- C -- ' -- distance -- L -- two -- one -- /-- two -- the range -- drawing -- inside -- an arrow -- meeting -- a raster scan -- carrying out -- making . Thereby, it becomes possible about Wafer W to make it deposit uniformly in the spatter particle of amount sufficient on the almost same conditions.

[0048] Next, in drawing 6 , the case where Wafer W is moved to a Z direction is explained. In this case, if the spatter gun assembly 12 is made to approach Wafer W, the prospective angle to the target 18 seen from the contact hole will increase, and more spatter particles will deposit on the shoulder of a contact hole. Moreover, conversely, if the spatter gun assembly 12 is kept away, a prospective angle will decrease and more spatter particles will deposit in a contact hole. Therefore, it becomes controllable [a membranous configuration] by moving Wafer W to a Z direction.

[0049] The range which moves the Z direction in this case is 100mm - 250mm, and it becomes movable to a Z direction, without making the capacity of the vacuum chamber 10 change, if it is this within the limits.

[0050] In addition, movement of X, Y, and a Z direction was uniquely movable, respectively, as mentioned above, it meets the need, and, on the other hand, may often combine these move directions only for Mukai in a gap. By combining these, it becomes possible to form a homogeneous high film more.

[0051] In addition, the axis of rotation may be set as the center of Wafer W other than movement of such X, Y, and a Z direction, and it may be rotated. It becomes possible to raise the homogeneity of film formation by this rotation on the periphery which connects the center of a target 18. In addition, you may only rotate independently by performing a rotation of Wafer W or more [of movement of X, Y, and Z shaft orientations] combining any one.

[0052] Moreover, you may carry out the eccentric rotation which makes a medial axis the eccentric shaft offset from the center of Wafer W. If it is going to raise the homogeneity of radial film formation when carrying out the rotation which sets the axis of rotation as the center of Wafer W as mentioned above, the distance from the center of a target of being located on the outskirts shall be differed separately. When it does in this way, it cannot but become difficult to make the array of the target 31 in a spatter gun assembly into the close-packed structure, and equipment structure cannot

but become complicated further. However, it becomes possible to raise the homogeneity of radial film formation in addition to a circumferencial direction, without making equipment structure complicated, making the array of a target 31 into the close-packed structure shown in drawing 5 , if an eccentric rotation is performed in this way. In addition, you may only rotate independently by performing a rotation of Wafer W also in this case or more [of movement of X, Y, and Z shaft orientations] combining any one.

[0053] Furthermore, the position of the medial axis of assembly 12a and the position of the medial axis of Wafer W are shifted, and you may make it rotate each for both sides. By producing such a rotation, it becomes possible to raise the homogeneity of film formation at a latus two-dimensional flat surface. What is necessary is just to adopt a magnetic seal and the hermetic seal which permits rotation of an O ring and others as a hermetic seal, in performing the above rotations.

[0054] In addition, the relative displacement of a sputtering gun and Wafer W cannot be restricted to an above-mentioned mode, and can be performed combining various X, Y, a Z direction, the circular motion, eccentric movements, and self-orbital motion. Moreover, such relative displacement may be intermittently performed using a step motor, and may be continuous movement.

[0055] Next, the modification of a sputtering gun is explained. As a sputtering gun used by this invention, the thing of structure as shown not only in the thing of the structure of drawing 2 but in drawing 7 and drawing 8 is employable.

[0056] Drawing 8 uses an electromagnet as magnetic field means forming using two or more magnets, without using a yoke for drawing 7 . In addition, in drawing 7 and 8, the same sign is substantially given to the same thing with drawing 2 , and explanation is omitted.

[0057] The pillar-like magnet 61 is arranged at an upper part [of a target 31], i.e., tooth back, side, and, as for the sputtering gun of drawing 7 , the annular magnet 62 is arranged at the nose-of-cam side of a target 31. The pole piece 63 which consists of the magnetic substance so that a gas passageway may be specified is connected to the target 31 side of a magnet 61. The screw thread is formed, and point 63a of the pole piece 63 is fixed with screws to the main part of pole piece, and can exchange only point 63a. Line of magnetic force is formed in a magnet 62 through the pole piece 63 from a magnet 61, and a magnetic field is formed in a crevice 32 like the sputtering gun of drawing 3 as a result. Refrigerant path 68a of a screw type is prepared in the target cooling block 36, and a refrigerant is supplied through the refrigerant feeding-and-discarding water pipe 68. Moreover, the cooling ring 66 for pole piece is formed in the circumference of the pole piece 63, refrigerant path 67a is formed in this cooling ring 66, and a refrigerant is supplied through the refrigerant feeding-and-discarding water pipe 67. Furthermore, the cooling ring 69 for anodes is formed in the circumference of an anode 34, and refrigerant path 69a is formed in it. the periphery of this sputtering gun -- a stainless steel -- it surrounds by the member 71 -- having -- **** -- a stainless steel -- it insulates by insulating member 72 between the member 71 and the target cooling block 36 in addition, the spacer with which the reference mark 65 intervened between the target 31 and the cooling block 36 -- it is -- 64 -- insulating member and 70 -- a clamp -- it is a member

[0058] The sputtering gun of drawing 8 has the same structure as the thing of drawing 3 fundamentally except having transposed the permanent magnet 38 in drawing 2 to the electromagnet 80. Thus, by using an electromagnet 80, current can be changed according to exhaustion of a target and the size of a magnetic field can be changed.

[0059] Next, other modes of this invention are explained. In the above-mentioned mode, although reactant gas, such as nitrogen, was introduced into the processing space 60 from the chamber 10, the example which prepared the reactant gas supply means in the sputtering gun itself is explained here.

[0060] Drawing 9 is the cross section showing the sputtering gun equipped with the reactant gas supply means. The sputtering gun of basic composition of drawing 9 is the same as that of drawing 7 , and gives the same sign to the same thing as drawing 7 . In drawing 9 , a reference mark 93 is a reactant gas source of supply for supplying reactant gas, such as nitrogen gas. The reactant gas from this reactant gas source of supply 93 passes along the reactant gas feed holes 94 formed in the spatter gun, and is introduced into the centrum of an anode 34.

[0061] on the other hand -- the argon gas as sputtering gas -- gas supply introduction -- a crevice 32 is supplied through a hole 40 In this case, argon gas has a high ionization efficiency in order to pass through a plasma field, and its sputtering efficiency is high. The spatter particle begun to beat by the

plasma generated in the crevice 32 passes and flies from a crevice 32 to the processing space 60 through the centrum of an anode 34. And in the centrum of an anode 34, reactant gas will be supplied to a spatter particle, it reacts by the operation of an electron which faces to an anode 34 from a crevice 32, a resultant particle is formed, this resultant particle deposits these on a wafer, and reactive sputtering is realized. For example, for a spatter particle, reactant gas is N2 at Ti. TiN can be made to deposit on a case. Also in this mode, since reactant gas is supplied to the field isolated from the crevice 32 in which the plasma of sputtering gas is formed, efficient reactive sputtering is attained.

[0062] Moreover, as other advantages in this example, in order to introduce reactant gas from the crevice between a target and an anode, it is mentioned that the wraparound of an inter-electrode spatter particle can be prevented. Since dispersion according [the pressure of the processing space 60] to the introductory gas of a spatter particle was furthermore lost for the low reason and the wraparound also decreased, the shield board of the circumference of processing space can also be made small.

[0063] Since exhaust air capacity can be increased by 1 figure, without being able to take the large conductance of sputtering gas and enlarging the exhaust, 2 figures of background pressures are improved according to the synergistic effect with the fall of an electric discharge pressure, and it contributes to a membraneous improvement greatly further again.

[0064] In addition, although the example which prepared the reactant gas supply means in the sputtering gun of drawing 7 fundamentally here was shown, it cannot be overemphasized that the same reactant gas supply means also as drawing 2 and the sputtering gun of drawing 8 can be established.

[0065] Although it is about 1 in case only argon gas performs sputtering/5, a membrane formation rate in case only nitrogen gas performs sputtering is a membrane formation rate of 3 times or more as compared with sputtering of only nitrogen gas, when nitrogen gas is supplied to the field to which the spatter particle is flying as mentioned above.

[0066] Moreover, it is desirable to impress negative direct-current bias, negative AC biases, or these both to a processed object as carried out in the usual sputtering from a membraneous viewpoint. The film formed becomes dense by this and membraneous quality improves further. When the film to form is TiN, thereby, membranous low resistance-ization can be attained.

[0067] In addition, this invention can deform variously, without being limited to the above-mentioned example. For example, although the above-mentioned example showed the example which used the semiconductor wafer as a processed object, it is not limited to this and can be applied to a LCD substrate, a magnetic disk, a magnetic tape, etc. Moreover, although the base material was moved according to the move mechanism, you may move a sputtering gun that the relative displacement between a processed object and a sputtering gun should just arise.

[0068]

[Effect of the Invention] According to this invention, the spatter particle of amount sufficient also in the hole of a highly-integrated wafer can be deposited, it is possible to carry out sputtering, where spatter gas ** of the whole sputtering processing space is maintained low, it is still more efficient, and the magnetron sputtering system which can carry out reactive sputtering, and a sputtering gun are offered.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
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3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The cross section showing the magnetron sputtering system concerning one example of this invention.
[Drawing 2] The cross section showing one mode of a sputtering gun used for the equipment of drawing 1 .
[Drawing 3] The cross section showing the example of the configuration of a target.
[Drawing 4] The cross section showing the magnetron sputtering system concerning other examples of this invention.
[Drawing 5] Drawing showing typically the array of the target in the assembly of the equipment of drawing 4 .
[Drawing 6] The ** type view explaining the relative displacement between the wafers and sputtering guns in the equipment of drawing 4 .
[Drawing 7] Drawing showing other examples of the sputtering gun used for the magnetron sputtering system of this invention.
[Drawing 8] Drawing showing the example of further others of the sputtering gun used for the magnetron sputtering system of this invention.
[Drawing 9] The cross section showing the sputtering gun concerning one example of this invention.
[Drawing 10] Drawing showing the state of forming a thin film in a contact hole using the conventional plate-like sputtering gun.
[Description of Notations]
10 -- vacuum chamber A 12 and 12a-- assembly and 14 -- base material 15 -- reactant gas supply pipe, 16, and 93 -- reactant gas source of supply The source of 18 -- sputtering gas supply, and 30 -- sputtering gun 31 -- target and 32 -- crevice 34 -- anode 38 -- magnet and 39 -- yoke 40 -- sputtering gas supply -- a hole and 45 -- power supplies 94 -- reactant gas feed holes S-- spatter particle
W -- Wafer

[Translation done.]

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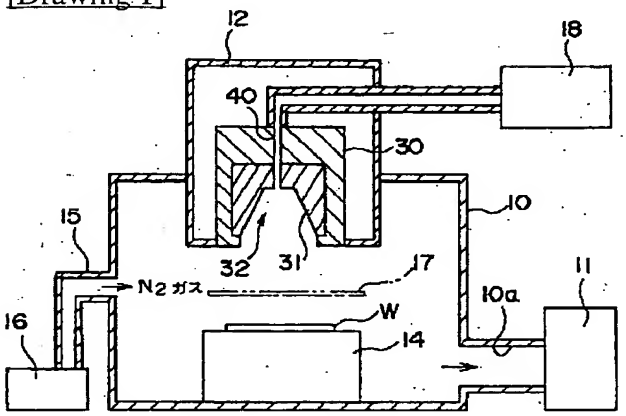
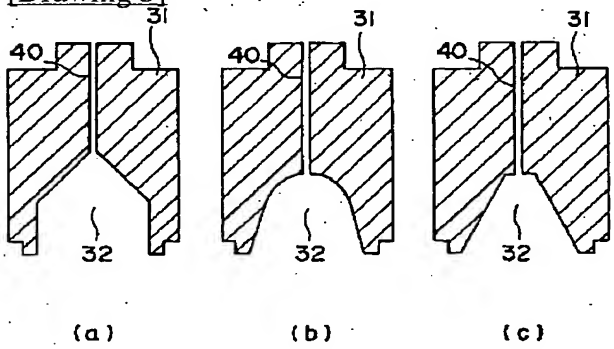
DRAWINGS

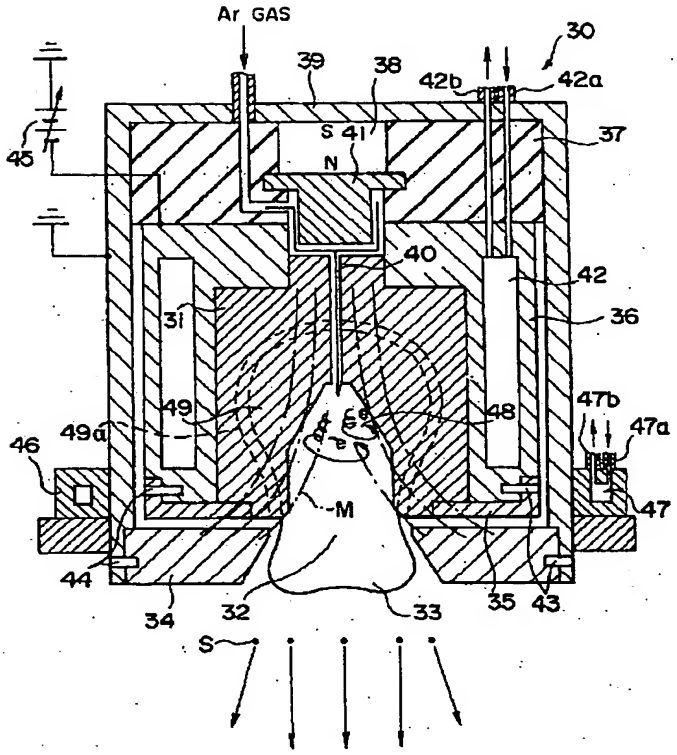
[Drawing 1]



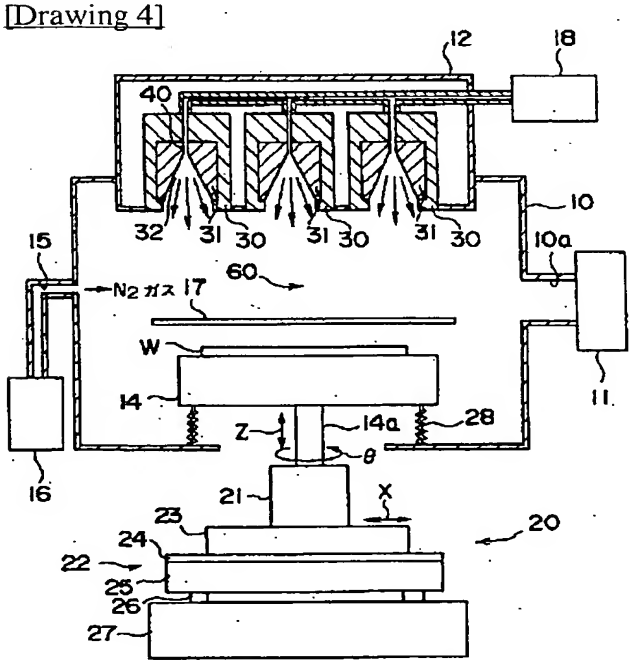
[Drawing 3]



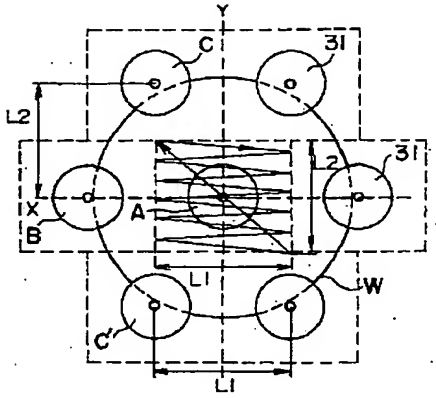
[Drawing 2]



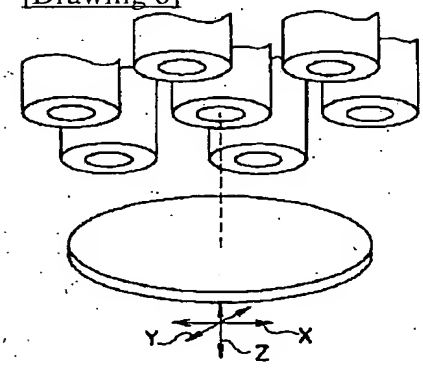
[Drawing 4]



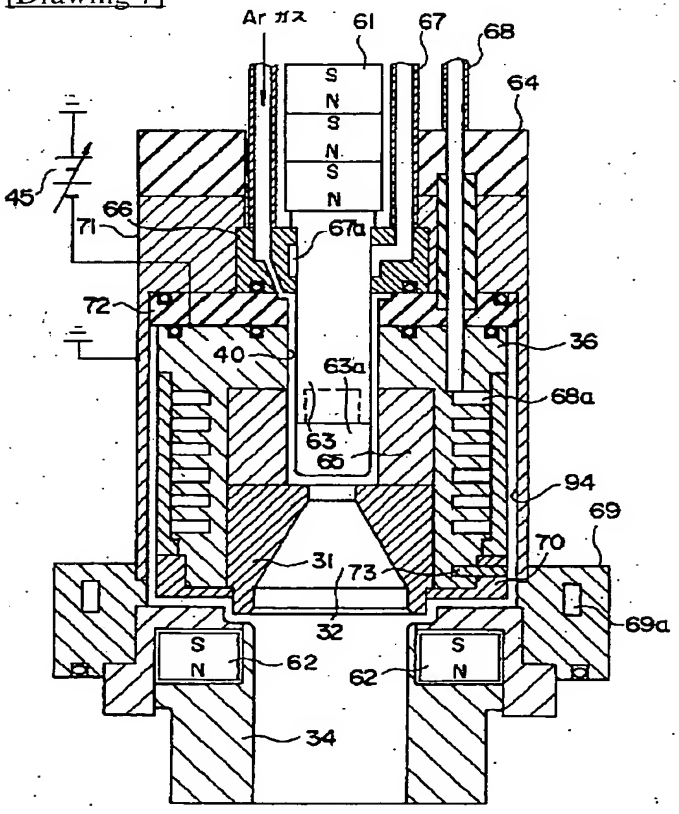
[Drawing 5]



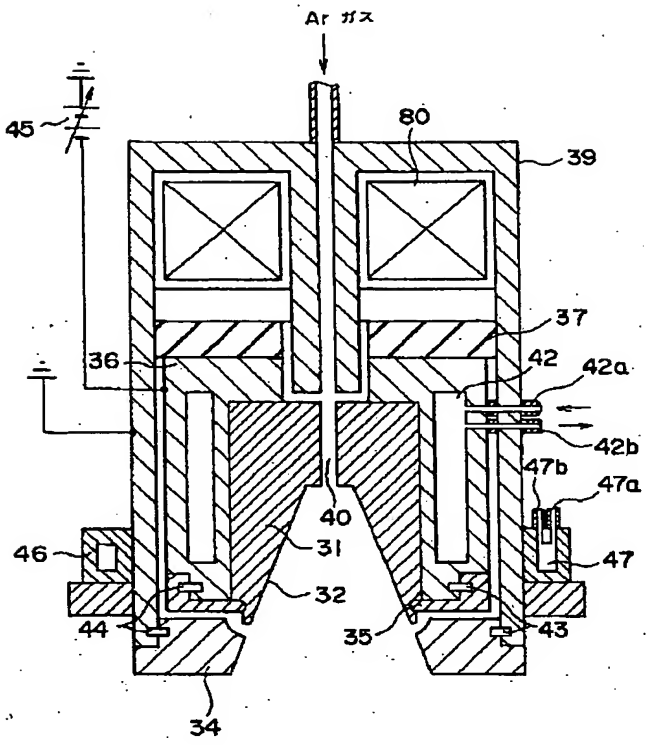
[Drawing 6]



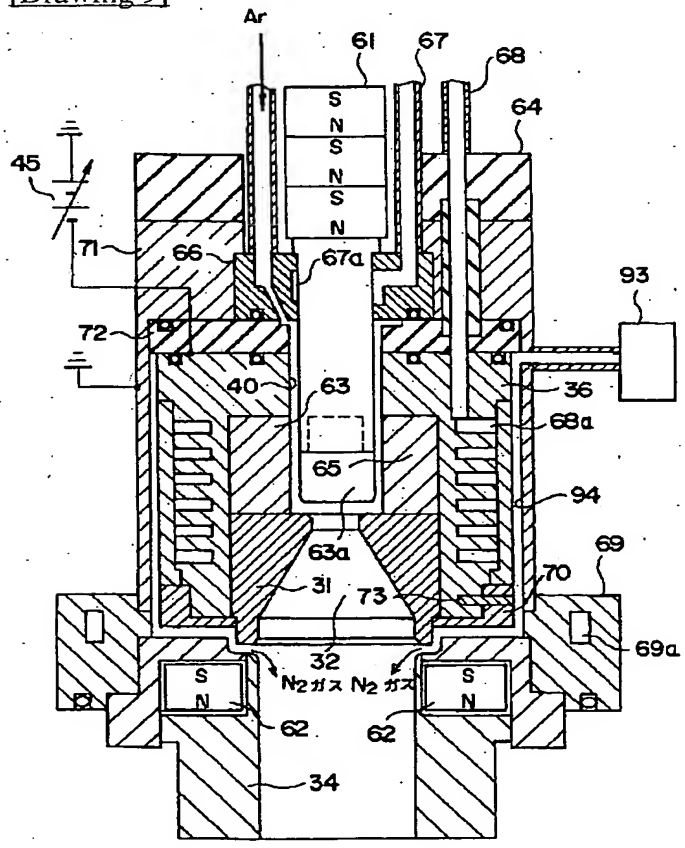
[Drawing 7]



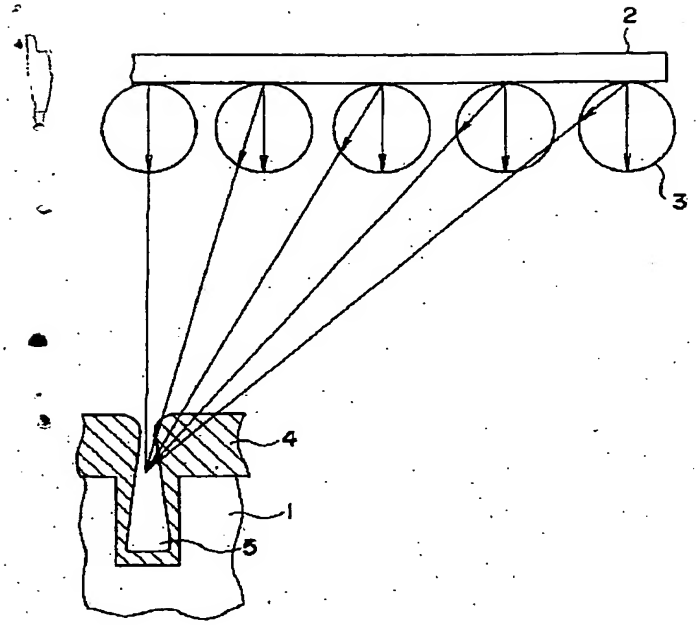
[Drawing 8]



[Drawing 9]



[Drawing 10]



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